STATUS OF MINERAL RESOURCE INFORMATION FOR THE MARICOPA (AK-CHIN) AND GILA RIVER INDIAN RESERVATIONS, ARIZONA

By

Jocelyn A. Peterson
U.S. Geological Survey

L. G. Nonini
U.S. Bureau of Mines

Administrative Report BIA-56
1979

CONTENTS

SUMMARY AND CONCLUSIONS

Deposits of sand, gravel, clay, and building stone are abundant within the study area and have been mined for many years as required for construction purposes. Although these resources are abundant, the trend since 1963 has been toward little or no production. Systematic development might reverse this downward trend because apparent markets are nearby, and transportation facilities are excellent.

Parts of the Gila River Reservation appear favorable for deposits of copper and possibly gold. Small quantities of ore have been produced from small, low-tonnage, high-grade deposits, and the area merits planned, systematic exploration for larger deposits. Deposits of mica, suitable for ground mica, exist on the reservation. Provided market conditions permit operation in competition with an outside, nearby producer, this resource is a development target. Limited deposits of high purity silica and pegmatites containing quartz, feldspar, and mica are present and might be developed if markets could be found.

Both reservations are favorably situated for potential geothermal resources that might warrant investigation.

Occurrences of titanium, corundum, limestone, and sodium nitrate are present on the Gila River Reservation. These resources have no commercial value at this time.

INTRODUCTION

This report was prepared for the Bureau of Indian Affairs by the U.S. Geological Survey and the Bureau of Mines under an agreement to compile and summarize available information on the geology, mineral resources, and potentials for mineral development of certain Indian lands. Source material included published and unpublished reports and personal communications. No fieldwork was done.

The setting of the two reservations with respect to Phoenix and other nearby cities, and to the Salt River and Fort McDowell Indian Reservations is shown on Figure 1. Both reservations (Figure 2) are irregularly shaped with the long axis of each striking roughly northwest-southeast. The Gila River Reservation is about 53 miles long and from 5 ½ to 22 ½ miles wide; the total area is 371,933 acres. The reservation ranges from 6 to 37 miles south of Phoenix, about one quarter being in Maricopa County and three quarters being in Pinal County. The Maricopa Reservation is about 13 miles long and from 1 ½ to 4 ½ miles wide; the total area is approximately 21,840 acres.

Topographically, both reservations consist of relatively level or gently sloping land lying along the drainage of the northwest flowing Gila and Santa Cruz Rivers. A few scattered buttes rise above the plain in parts of the Gila River Reservation; the Sierra Estrella Mountains run northwesterly along the western boundary and the Sacaton Mountains cluster at the southern boundary. The Maricopa Reservation is nearly flat, containing no noticeable hills or buttes. Maximum relief on the reservations is 3,414 feet between Montezuma peak (4,354 feet) and the junction of the Salt and Gila Rivers (940 feet).

On the Maricopa Reservation most of the land lies between 1,147 feet and 1,255 feet in elevation, gently sloping toward the principal drainages at slopes rarely exceeding 10 feet per mile. Most of the Gila River Reservation is between 950 feet and 1,390 feet in elevation, and also slopes toward the principal drainages at a rate of about 10 feet per mile. The more mountainous areas are much steeper. Drainage is by ephemeral streams flowing into several washes that course northwest and ultimately join the intermittent Gila River, which also flows northwesterly through the long axis of the Gila River Reservation.

The climate is arid; annual rainfall recorded at Maricopa varied from a minimum of 0.38 inches in 1882 (Bryan, 1926) to a maximum of 16.42 inches in 1941 (Sellers, 1960). At Sacaton, from 1931 to 1972, the high was 17.21 inches in 1941 and the low 1.85 inches in 1956. The average for the period was 8.10 inches (Sellers and Hill, 1974). The driest period of each year is normally from April through June and the hottest period in July and August. Temperatures often exceed 100ºF in the summer and occasionally go below freezing in winter.

Historically, agriculture has been the dominant industry. Irrigation is necessary, originally accomplished by means of dams, canals, and ditches, but more recently, pumping of ground water has been required (Lee, 1904). Currently there are about 86,000 acres being irrigated on the two reservations (Bureau of Indian Affairs, Phoenix Office, 1978). In some areas water tables are dropping rapidly, and on the Maricopa Reservation this has resulted in a reduction in the amount of land under cultivation (U.S. Bureau of Indian Affairs, 1978).

In the last few years, development of industry, tourism, and recreation have been emphasized. These efforts have attracted many manufacturing firms and have resulted in the creation of four industrial parks, three on the Gila River Reservation and one on the Maricopa Reservation. This diversification, facilitated by the proximity to Phoenix, has lessened the necessity to rely solely upon agriculture for livelihood. The total income for the Gila River Reservation is $15,433,000 (U.S. Bureau of Indian Affairs, 1978); a figure for Maricopa is not given but might bring the total for both to about $16,000,000.

Sacaton is tribal headquarters for the Gila River Reservation and Ak-Chin for the Maricopa Reservation; these and other settlements provide most basic community facilities. Phoenix to the north and Casa Grande to the south provide other facilities that are not available on the reservations.

The transportation network is excellent. Interstate Highway 10 crosses north-northwesterly through the Gila River Reservation, and six state highways serve the area in both north-south and east-west directions. All parts of the reservation are accessible by paved or dirt secondary roads. The same is true of Maricopa Reservation, which is traversed by three state highways and completely accessible by a network of secondary roads. Both reservations are served by the Southern Pacific Railroad. Scheduled airline service is available in Phoenix, and there are several airstrips on or near the reservations.

PREVIOUS INVESTIGATIONS

An excellent and comprehensive study of the mineral resources of the Gila River Indian Reservation by E. D. Wilson was published in 1969. No other published descriptions of the mineral deposits of either the Gila River or the Maricopa Reservations could be found. Bryan (1925, page 221) refers to an unpublished report by Frank C. Schrader (1918) regarding minerals on the Gila River Reservation. Several U.S. Geological Survey reports by Newell (1891), Davis (1897), Lippincott (1900), and Lee (1904 and 1905) discuss water supply for the reservations. Chaffee (1976) discusses geochemical work done on the Gila River Reservation. Bryan (1925) and Darton (1925 and 1933) have described the geology. Geology is also covered by geologic maps of Maricopa and Pinal Counties by Wilson and others (1957 and 1959).

GEOLOGY OF THE PHOENIX AREA

All of the mountain ranges and basins in the Phoenix area are geologically similar. For this reason the following outline of the geology describes a much larger area than that occupied by the Gila River and Maricopa Reservations.

Mountain chains with cores of Precambrian granitic and schistose rock and valleys of Cenozoic sediments and sedimentary rocks that may attain great thicknesses typify the Phoenix area (Figure 3). A few small Laramide stocks and minor outcrops of Paleozoic and Mesozoic sedimentary and volcanic rocks are present within the mountains. Both early and recent investigators primarily studied ore occurrences within the mountain ranges or ground water in the basins. The geology of the Gila River and Maricopa Reservations is shown on Figure 4.

Rock Units

Precambrian

Precambrian schists, gneisses, and granites constitute the mountain cores and comprise almost the entire Sierra Estrella and Sacaton Mountains. Geologists distinguish three types of granite: 1) in the McDowell and Phoenix Mountains is a medium-coarse to very coarse light gray granite containing orthoclase, biotite, and quartz; 2) in the South (also called Salt River), Usury, and Goldfield Mountains is a medium-fine to medium--coarse granite similar to that mentioned above but containing more biotite and quartz; 3) there are small exposures in the Camelback, McDowell, and Santan Mountains of a coarse granite containing pink potassium feldspar altered to sericite, biotite usually altered to chlorite and epidote, and quartz. Although these granites have not been named, they probably correlate with the Oracle or Ruin Granites in other parts of Arizona. The Precambrian schists are of both igneous and sedimentary origin. The transition from biotite granite to gneiss can be traced in the White Tank and South Mountains west and south of Phoenix (McDonald and others, 1947). These schists are less thinly laminated than those of sedimentary origin. McDonald and others (1947) think some schists in the Phoenix, McDowell, and Heiroglyphic Mountains are probably of sedimentary origin due to their spatial association with quartzites, slates, and shales. These well-foliated schists strike uniformly to the northeast and dip steeply, while schists in other areas show more variations in strike. The minerals in all of these schists include sericite, muscovite, chlorite, epidote, and quartz.

Paleozoic, Mesozoic, and Laramide

A small outcrop of Cambrian(?) quartzite and Devonian(?) limestone occurs in the Sacaton Mountains (Wilson, 1969). Wilson considers a small granitic body in the southern Sierra Estrella to be Mesozoic, and he also notes minor occurrences of Mesozoic diorite dikes. Stocks and aplitic dikes in the Santan Mountain area are probably Laramide. When considering mineral resource potential, the limited extent of these Paleozoic and Mesozoic sedimentary rocks makes them an unlikely major source of ore minerals, but the Mesozoic and Laramide stocks may be significant for copper mineralization.

Volcanic Rocks

Volcanic rocks ranging in composition from rhyolite to basalt occur in most of the Phoenix area mountain ranges (Moore and Varga, 1976) and are probably Tertiary in age (Wilson, 1969).

Sedimentary Rocks

Most of the sedimentary rocks filling the valleys are Quaternary but McDonald and others (1947) believe that some red conglomerates and sandstones in the McDowell Mountains and other sedimentary rocks in the Phoenix Mountains--Tempe Butte area (Figure l) are Tertiary. These older sediments have intercalated volcanic rocks.

Quaternary sedimentary rocks and sediments constitute most of the basin fill. They are composed of gravel to clay sized particles and are well cemented to unconsolidated. Rock and mineral grains were derived from local sources and carried by streams of widely varying volume; the mountain ranges are burying themselves in their own debris. McDonald and others (1947) believe most of the sedimentary rocks are Pleistocene in age and that there is not much recent alluvium, although there is little fossil evidence to support or refute this. Some caliche can be found in the valleys. These Quaternary sedimentary rocks fill the basins to depths of greater than 1,200 feet (Figure 3).

Structure

The Phoenix area is in the Basin and Range physiographic province characterized in this part of Arizona by northwest-trending mountain ranges between large valleys. Few papers discuss structural details of the area except to mention that the Precambrian rocks have been highly fractured (White, 1963).

Geophysics

Peterson and others (1963) discuss the gravity and aeromagnetic data for the Phoenix area. Essentially, the large aeromagnetic anomalies merely delineate areas of granites and gneiss and the lesser anomalies outline volcanics. The gravity data imply that there is a deep basin north of the Palo

Verde Hills (west of Maricopa Reservation) and another 13 km west of Glendale which proved to be a salt dome (Eaton and others, 1972). Data suggest that a fault zone extends from Scottsdale to the Palo Verde Hills that may have had locally significant vertical displacement. Paradise Valley (which includes part of the Salt River Reservation) has three particularly low anomalies. Another noticeable low occurs between the Sacaton and Palo Verde Mountains (in vicinity of the Maricopa Reservation).

MINERAL RESOURCES

General

Mineral occurrences on the reservations are of two general groups: (1) those found in the alluvial materials that cover all the Maricopa Reservation and about 85 percent of the Gila River Reservation, and (2) those found in the older rocks that protrude through or lie beneath the alluvium. The first group includes clay, gravel, nitrate, and sand; the second group includes copper, corundum, feldspar, gold, lead, limestone, mica, silica, stone, titanium, and tuff (Figure 5).

Prospecting on the Gila River Reservation commenced prior to 1868 when U.S. Land Office Plats first noted several copper mines in the Sierra Estrella (Wilson, 1969). Since then sporadic interest has been directed toward various minerals on the two reservations, but with the exception of sand and gravel no substantial or sustained production has been obtained.

Metallic Mineral Deposits

Introduction

For many years the Gila River Reservation and surrounding areas have been prospected intermittently for base and precious metals. The close proximity of the Sierra Estrella to transcontinental travel routes resulted in early (pre 1868) prospecting of the copper and gold-bearing veins in that range (Wilson, 1969).

Gold veins also were found in the foothills of the Salt River (South) Mountains inside the north boundary of the Gila River Reservation before 1900. Iron-and copper-stained outcrops in the Sacaton Mountains and along the northern boundary of the eastern portion of the Gila River Reservation led to early prospecting that has continued intermittently up to the present. Lead has been found in small amounts in the Sacaton Mountains. Titanium, as rutile, along with corundum, as irregular nodules in felsite dikes, have been found in non-commercial quantities in the same range (Wilson, 1969).

Copper Deposits

Near the northeastern corner of the Gila River Reservation in T. 4 S., Rs. 7 and 8 E., iron-stained outcrops attracted early attention. Such attention has continued intermittently. The area was tested by pits and trenches and many claims were located. Exploratory drilling was carried out by the Sacaton Copper Co. in 1922 and 1923, by Bear Creek Mining Co. in 1963 (Wilson, 1969), by Duval Corp. from 1966-75, by Exxon Co. in 1972-73, and by ASARCO, Inc., in 1976-77 (Gila River Indian Community Files). Copper and molybdenum mineralization was encountered by all investigators, but apparently no minable ore body was located.

Chrysocolla and copper minerals are found in fractures in silicified, sericitized granite. Some of the granite contains enough iron oxides to color the rock brownish-red, and in places it has a texture and color suggesting gossan (Wilson, 1969). The principal structural trends appear to be northeasterly and northwesterly, fitting into the regional pattern of mineralization.

In the southern portion of the Gila River Reservation, in the Sacaton Mountains, shallow prospect shafts explore steeply dipping, northeast and northwest striking fracture zones, up to 6 feet wide, stained with iron oxides, chrysocolla, and other secondary copper minerals. A grab sample of dump material taken by Wilson showed 2.8 percent copper, 0.03 ounce of gold per ton, and 0.9 ounce of silver per ton, potential ore by today's standards. Wilson states, "The exposed deposits are small and appear to offer very little promise of future commercial importance."

In 1973-74, James Sullivan Co. test drilled an area about 2,500 ft by 2,500 ft in the southwest corner of sec. 7, T. 5 S., R. 6 E. Commercial grade mineralization was found, but not in sufficient quantity to constitute an ore body. Areas having significant potential for porphyry copper deposits remain untested (James Sullivan Co., 1974).

Exploration 2 ½ miles south and outside of the reservation boundary has disclosed two ore bodies containing a total of 47.5 million tons of ore averaging 0.76 percent copper. This property, the Sacaton mine, is being mined by ASARCO, Inc.

The Sacaton copper deposit, south of the reservation, was discovered while investigating the mineralized belt that trends southwesterly from the Miami-Superior area; the only surface expression was a single granite-quartz monzonite outcropping showing sericitic and argillic alteration (Robert B. Cummings, oral communication). Subsequent drilling located the west and east ore bodies under 250 feet and 1,500 feet of alluvium, respectively (Pay Dirt, 1974).

The Casa Grande copper deposit, 7 miles south of the Gila River Reservation on the same lineament mentioned above, contains at least 350 million tons of 1 percent copper (Hanna Mining Co., 1978). Test drilling is continuing on this deposit, and production is anticipated in the mid 1980's. This deposit was also discovered through study of regional structures and test drilling (R. Craig Smith, oral communication) to depths below 1,600 feet.

An interesting feature is the remarkable alignment of copper deposits between Ajo on the southwest and Miami on the northeast, including Magma-Superior, Sacaton, Casa Grande, and the known copper mineralized areas in the Gila River Reservation. Projection of this alignment suggests a mineralized zone through the study area, as indicated on Figure 5. If the Christmas, Florence, Vekol Hills, and Lakeshore deposits are also considered, the mineralized zone may be wider than shown on Figure 5 and might include all of the southeastern portion of the Gila River Reservation.

The significance of these discoveries to this study is simply that the southeastern portion of the Gila River Reservation and that portion lying along the course of the Santa Cruz and Gila Rivers running northwesterly to a junction with the Salt River appear to be on major mineralized zones that are prime exploration areas for large low-grade mineral deposits. Of the two zones, the one running northeasterly in the southeast portion of the Gila River Reservation is probably the most promising. On the basis of present information, neither of the two zones appears to underlie the Maricopa Reservation.

The greatest problem in exploring the reservations is that most of the area is covered by alluvium up to 1,500 feet in thickness. Under certain conditions, such depths may be too great for dependable results from existing geophysical techniques, and the area involved is too large to permit economic coverage by grid drilling. However, detailed geological study of structural and alteration patterns of existing outcrops and all drilling results obtained to date, combined with geochemical and geophysical results from areas of thin alluvium, could possibly locate likely targets for further exploratory test drilling.

Gold Deposits

Gold-bearing quartz veins and breccia zones, are found in the foothills of the Salt River (or South) Mountains in secs. 2-6, T. 2 S., R. 3 E. Most veins strike northwesterly but occasionally east-west and northeasterly and have steep dips. They are lenticular, often disrupted by faulting, and range from less than 2 inches to 24 inches in width (Wilson, 1969). Some ore was treated in arrastres and some was shipped. Despite considerable early-day prospecting and leasing up until June 1956 (Office files of Gila River Indian Community), only a small quantity of ore has been produced. It is unlikely that the deposits could support any but the smallest of operations.

Gold and Copper Deposits

Apparently the mineral deposits in the Sierra Estrella, secs. 6, 7, 17, and 31 of T. 3 S., R. 2 E., were the first in the study area to attract the attention of travelers on the nearby transcontinental routes. Wilson (1969) points out that the Land Office records of 1868 mention the deposits. A number of quartz veins occur in fractures that strike generally northeasterly or northwesterly and dip westerly or vertically. The veins range from less than 1 foot to 15 feet wide and contain small, irregular, scattered masses of chrysocolla, limonite, and hematite. A small amount of ore evidently was produced, but in Wilson's opinion the deposits "do not seem to offer much future promise; besides being difficult of access, they are small, lenticular, and not of high grade." A sample taken by Wilson across a width of about 18 inches assayed 3 percent copper, 0.22 ounce of gold per ton, and 0.35 ounce of silver per ton. By today's standards, this would be very good ore, provided sufficient quantity could be found.

An interesting aspect of these veins is that, for the most part, they appear to parallel, and conceivably could be related to, certain regional structures that some writers believe have bearing on mineralization (Landwehr, 1967) (Wertz, 1970). The

Sacaton copper deposit, south of the Gila River Reservation, is divided by a northwesterly striking fault with a vertical displacement of about a thousand feet, the eastern side being the down thrown block (Robert B. Cummings, oral communication). Theoretically this fault could be projected into the vicinity of the Sierra Estrella copper-gold deposits, possibly along the course of the Gila River. Such a theory leads to speculation concerning the possibility of other deposits in rocks underlying the alluvium.

Lead Deposits

A report for the Committee on Interior and Insular Affairs (U.S. Geological Survey and others, 1969) states that a small amount of lead ore was shipped from the Sacaton Mountains in 1939. No other details were given, and no other references to lead deposits on the reservations have been found. It is not known that these shipments were produced from within the reservation.

Titanium Deposits

Wilson, 1969, describes a titanium deposit in the Sacaton Mountains in the southeastern portion of sec. 12, T. 5 S., R. 5 E. The titanium occurs as rutile associated with corundum and quartz. Irregular masses of the intergrown minerals up to several inches in diameter are found in felsite dikes intruded into coarse grained, iron stained granite. The small size and discontinuous nature of the deposit precludes commercial development.

Nonmetallic Mineral Deposits

Introduction

Nonmetallic minerals produced on the reservations are those used in construction work, such as sand and gravel for fill and aggregate, clay for adobe, and stone for crushed rock and dimension stone. All are found in abundance and are produced as required.

Other nonmetallics, including mica, quartz, feldspar, tuff and limestone, are present in quantities that might prove commercial under proper circumstances.

Still others, such as corundum in the felsite dikes and sodium nitrate on the alluvial plains, are known to exist but are of academic interest only because the deposits are insufficient in either quantity or grade to be economic.

Clay

Wilson (1969) reported that large deposits of useful clay are found in those portions of the Gila River Plain that have escaped sand and gravel sedimentation from floods and washes. He collected more than 50 clay samples from readily accessible deposits. Tests determined that most of the clays were suitable for adobe construction by traditional methods as well as by stabilization techniques; some of the clay is suitable for the manufacture of bricks, and others clays have bloating or expanding properties making them suitable for the manufacture of lightweight aggregates. Brick clay was found in T. 1 S., R. 1 E., Tps.

2 and 3 S., R. 2 E., T. 3 S., Rs. 5 and 6 E., and T. 4 S., Rs. 5, 7, and 8. Bloating clay was found in T. 3 S., Rs. 5 and 6 E., and in T. 4 S., Rs. 6, 7, and 8 E.

It appears that the potential for a clay industry is present but dependent upon development of markets in Phoenix and Casa Grande. The clay deposits probably are as variable as the sand and gravel deposits, and thorough exploration should be conducted prior to establishment of any type of plant.

Corundum

Corundum has been found on the pediment area of the Sacaton Mountains in the southwest corner of sec. 12, T. 5 S., R. 5 E. Crystalline corundum, with rutile and quartz, forms irregular masses up to several inches in diameter in felsite dikes that have been intruded into a coarse grained granite (Wilson, 1969). The small size and irregular nature of the mineralization make it unlikely that the deposit will be developed commercially.

Feldspar

Feldspar, as microcline and oligoclase, is found intergrown with quartz and mica in the pegmatites cited. It is technologically possible to separate these minerals into separate fractions if the demand and the size of the deposits justified the expense. It is doubtful that the known deposits merit such consideration.

Limestone

A single deposit of limestone has been found on the Gila River Reservation in the Sacaton Mountains in sec. 7, T. 5 W., R. 6 E. The outcrop is a few tens of feet wide and is exposed for only a short length before it disappears beneath the alluvium. An analysis by Wilson shows:

CaO - 46.0% or $CaCO_3$ - 80.5%
MgO - 6.7% or $MgCO_3$ - 14.0%
SiO_2 - 4.0% or SiO_2 - 4.0%
Fe - 0.8% or Fe_2O_3 - 1.1%

Based on this analysis, the limestone is not suitable for cement due to its high magnesium content (Brown, 1975); the silica is higher than is desirable for flux (Carr and Rooney 1975); and the combined $CaCO_3$ - $MgCO_3$ content is too low for dolomitic burned lime (Boynton and Gutshick, 1975). This material could be used for agricultural limestone (Carr and Rooney, 1975), although the apparent small size of the deposit is not conducive to its development. It is unlikely that this deposit will be utilized as long as more favorable alternatives exist.

Mica

Pegmatite dikes are found in the Sierra Estrella, especially in secs. 6-8, T. 4 S., R. 2 E., and in the Pima Butte area of secs. 13 and 23-27, T. 3 S., R. 3 E. The pegmatites range from 1 foot to 40 feet wide and up to 100 feet long, although most are less than 50 feet long. Minerals in the pegmatites are quartz, feldspar, and both muscovite and biotite mica. Most of the mica books are less than an inch in diameter, although books 2 inches thick, 6 inches wide, and 12 inches long have been found. All of the sheets are ruled, rumpled, and flawed and are suitable only for ground mica.

Wilson (1969) found that the schistose wall rock of the pegmatites contains more than 20 percent mica over minable widths, and he believes that it holds more promise as a mica source than the pegmatites. Mica from deposits west of the Sierra Estrella outside the study area is being mined and ground commercially. A thorough market study and an investigation of the tonnage available should precede any attempt to develop deposits on the reservation.

Nitrates

Sodium nitrate occurs on the silt flats of the Santa Cruz River in secs. 7, 8, 17, and 20, T. 3 S., R. 3 E. The sodium nitrate is found in thin surface crusts and in the upper few feet of soil. Wilson noted that the crusts contain less than 0.1 percent sodium nitrate and 1.5 to 2.6 percent sodium chloride. The deposits are of no commercial value.

Sand and Gravel

As shown on Figure 5, deposits of sand and gravel are well distributed throughout the area. If needed, additional deposits may be located by exploration. In general, access and low-cost transportation are the most important factors in the establishment of a pit.

The deposits, which underlie and interfinger with beds of silt and clay, were laid down by meandering, shifting, drainage systems, and hence the physical characteristics of the deposits vary considerably both vertically and horizontally from place to place. Because of the irregularity of the deposits, thorough exploration should be carried out prior to planning any relatively permanent washing and screening facility.

The close proximity of Phoenix and Casa Grande and the excellent transportation network place the deposits in a favorable position for commercial development. Wilson (1969) considers the ratio of sand and gravel to waste material more favorable on the reservations than for competitive deposits along the Salt River. It appears the deposits may be worthy of development if markets are found

Past production has been carried out through the issuance of permits to industry, the Arizona State Highway department, and local Indian service projects. Although production figures are not complete, Wilson estimates that more than 150,000 tons was produced under permits during 1942-1945 and 447,000 tons during 1956-1963. Production ranged between 5,600 tons in 1960 and 327,000 tons in 1963. Bureau of Indian Affairs reports show a decrease of production to only 800 cubic yards (approximately l,200 tons) for 1977 and none for 1978.

Silica/Quartz

Deposits of high purity silica or quartz are found in the study area (Wilson, 1969). The pegmatites mentioned could yield commercial grade silica, as well as mica and feldspar, if the size of the deposits and the market demand were sufficient to justify the construction of a treatment plant to separate the pegmatites into their constituent minerals. Sources simpler and easier to deal with include two quartz veins in sec. 31, T. 3 S., R. 2 E., of the Sierra Estrella, a quartz vein in sec. 9, T. 5 S., R. 6 E., two quartz veins in sec. 7, T. 5 S., R. 6 E., and a quartzite ridge in sec. 7, T. 5 S., R. 6 E.; the latter four deposits are all in the Sacaton Mountains.

The quartz veins in the Sierra Estrella are rather small, one being 30 feet long and 5 feet wide, the other 25 feet long and 1 to 5 feet wide.

The veins in the Sacaton Mountains are larger; the one in section 9 is 60 feet long and 25 feet wide. Of the two veins in section 7, one is about 250 feet long and 150 feet wide while the other is about half that size. The quartzite ridge in section 7 is by far the largest silica deposit in the study area, being about 2,500 feet long and 250 feet wide. The iron content, reported by Wilson as 0.62 percent, is too high to make the rock satisfactory for clear or white glass manufacture (Mills, 1975) but it would be suitable for smelter flux and roofing granules. The vein quartz, although in less quantity, appears to be of a higher quality and might be found satisfactory for glass, silicon, and ferrosilicon manufacture and possibly for silicon carbide manufacture.

Stone

Granite and basalt have been quarried on the Gila River Reservation for use as crushed rock and rough dimension stone in building dams, roads, buildings, and other construction for many years. Operation is intermittent and fluctuates widely with the demand. Apparently no records of production have been maintained. Wilson (1969) has listed a number of suitable quarry sites. In the Santan Mountains, sec. 3, T. 4 S., R. 7 E., granite was quarried for railway fill in 1924-25. At Olberg, sec. 7, T. 4 S., R. 7 E., granite and basalt were quarried for use as fill and rip-rap in dam construction. In Tps. 3 and 4 S., R. 6 E., basalt boulders useful for exterior walls are found. In the Sierra Estrella, in secs. 27, 33, and 34, T. 3 S., R. 2 E., good quality granite is found well situated for quarry sites and transportation. At Pima Butte, in sec. 13, T. 3 S., R. 3 E., granite has been quarried for use as crushed rock. It is near a good transportation route.

These and other sites could be developed if the demand in Phoenix and Casa Grande is sufficiently large.

Tuff

A tuff bed up to 500 feet thick has been reported by Wilson (1969) in the Santan Mountains, Tps. 3 and 4 S., Rs., 6 and 7 E. The tuff is locally interbedded with some sand and gravel and is associated with latitic volcanic flows overlying older basalt, granite, and schist. Apparently the tuff has not been investigated, and no attempt has been made to use it.

In other places, tuff has been found useful as building stone. It often has pozzolanic properties that allow it to be used both to reduce the amount of cement needed in making concrete and to improve the quality of the concrete (Davis 1964), (Mielenz, 1948), (U.S. Bureau of Mines, 1969). Tuff is sometimes bentonitic or sometimes zeolitic (Eyde, 1978), and may form commercially minable deposits of those minerals. Nothing has been published about the physical properties of the considerable tuff deposits in the study area.

Geothermal Energy

The central portion of both the Gila River and the Maricopa Reservations are areas in which well temperatures and geothermal gradients indicate high subsurface temperatures (Hahman, Stone, and Witcher, 1978). In 1973, the Gresham Geophysical Corp. of Phoenix, Ariz. obtained a one year permit to explore the Maricopa Reservation for geothermal steam and hot water. The corporation claims to have spent $77,000 in drilling and testing (Nulle, 1974). Records of the work done by Gresham Geophysical Corp. could not be located; however, no geothermal energy has been developed to date. Dr. John S. Sumner of the University of Arizona confirms (oral communication) that exploration in the vicinity of the reservations has shown high geothermal gradients and bottom hole temperatures, near the boiling point, at depths around 3,300 feet.

It is probable that geothermal resources could be developed on both reservations. Preliminary geochemical indicators and geothermal gradients suggest that subsurface temperatures may be sufficiently high for generation of electrical power; however, this may only be determined by exploration. Lower temperature steam could be used for processing food, milk, and agricultural products, and in manufacturing processes. Such an asset could be a valuable adjunct to the industrial parks now existing on the reservations. Low temperature steam and hot water are useful for heating greenhouses, dwellings, and buildings, but would be of limited value for such purposes in the warm climate of the area.

MAP COVERAGE

The Geological Survey has published 15-minute and 7 ½ minute quadrangle topographic maps, at scales of 1:62,500 and 1:24,000 respectively, that cover the reservations as shown on Figure 6. Geological Survey 1:250,000-scale topographic maps Phoenix (NI 12-7), Mesa (NI 12-8), Ajo (NI 12-10), and Tucson (NI 12-11) include the reservations. The U.S. Geological Survey and the Arizona Bureau of Mines have published a "Geologic Map of Arizona" at a scale of 1:500,000. The Geological Survey also publishes a base map on a 1:500,000 scale which shows the reservation locations. The above maps are all available from:

U.S. Geological Survey
Distribution Branch, Central Region
Box 25286, Denver Federal Center
Denver, Colo. 80225

The Arizona Bureau of Mines has published a "Geologic Map of Maricopa County" and a "Geologic Map of Pinal County" on a scale of 1:375,000, and a "Map of known nonferrous base and precious metal mineral occurrences in Arizona" on a scale of 1:1,000,000. These are available from:

Arizona Bureau of Geology
and Mineral Technology
845 North Park Avenue
Tucson, Ariz. 86719

Individual county road maps for Maricopa and Pinal Counties at scales of 1 ½ inches = 2,000 ft and 1 ¼ inches = 5 miles are available from:

Arizona Department of Transportation
Engineering Records, Room 134 A
206 South 17th Avenue
Phoenix, Ariz. 85007
Telephone (602) 261-7325

Aerial photographs of the reservations can be obtained from:

EROS Data Center
U.S. Geological Survey
Sioux Falls, S. Dak. 57198

RECOMMENDATIONS FOR FUTURE WORK

The Gila River Reservation has been mapped geologically and studied in some detail for mineral deposits. The Maricopa Reservation has been neither geologically mapped nor studied in detail. Because of the thick alluvial cover and the seeming absence of rock outcrops, it is doubtful that such work would be productive.

Work that the tribes might consider to promote the development of mineral resources of the study area are:

1. Geological study of the entire area, but especially the Gila River Reservation, with regard to rock alteration patterns and structural features, combined with geochemical and geophysical surveys. The objective would be to locate promising drilling targets for porphyry copper mineralization.
2. Geological mapping and sampling of the tuff beds on the Gila River Reservation to determine whether they possess qualities of commercial value.
3. Preliminary investigation, probably including systematic geothermal gradient measurements, to define areas worthy of test drilling for geothermal resources.
4. Market surveys in the Phoenix, Casa Grande, and Tucson areas for silica, feldspar, ground mica, sand, gravel, bricks, brick clay, expanded clay, dimension stone, and crushed rock. The purpose would be to determine whether systematic development of resources known to be present on the reservations is justified.

REFERENCES

Ames, J. A., 1975, Cement and cement raw materials in Industrial Minerals and Rocks, 4th Edition: American Institute of Mining, Metallurgical and Petroleum Engineers, p. 129-155.

ASARCO, Incorporated, 1977 Minera1. Prospecting Permit No. GR-PP-1-76, letter, drill logs and location map of 7 drill holes: Office files of Gila River Indian Community.

Boynton, R. C., and Gutshik, K. A., 1975, Lime in Industrial Minerals and Rocks, 4th Edition: American Institute of Mining, Metallurgical and Petroleum Engineers, p. 737-736.

Brown, B. C., 1975, Cement in Mineral facts and problems: U. S. Bureau of Mines Bulletin 667, p. 205-221.

Bryan, Kirk, 1925, The Papago Country, Arizona: U. S. Geological Survey Water Supply Paper 499, 436 p.

Carr, D. D., and Rooney, L. F., 1975, Limestone and dolomite in Industrial Minerals and Rocks, 4th Edition: American Institute of Mining, Metallurgical and Petroleum Engineers, p. 757-789.

Chaffee, M. A., 1976, Geochemical exploration techniques based on distribution of selected elements in rocks, soils, and plants, Mineral Butte Copper Deposit, Pinal County, Arizona: U.S. Geological Survey Bulletin 1278-D, 55 p.

Cooley, M. E., 1973, Map showing distribution and estimated thickness of alluvial deposits in the Phoenix area, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map 845-C.

Dale, V. B., 1961, Tungsten deposits of Gila, Yavapai, and Mohave Counties, Arizona: U.S. Bureau of Mines, I.C. 8078, 104 p.

Darton, N. H., 1925, A resume of Arizona geology: Arizona Bureau of Mines Bulletin 119, 227 p.

_____1933, Guidebook of the western United States, Part F., The Southern Pacific Lines, New Orleans to Los Angeles: U.S. Geological Survey Bulletin 845, p. 197-201.

Davis, A. P., 1897, Irrigation near Phoenix, Arizona: U.S. Geological Survey Water Supply Paper 2, 95 p.

Davis, R. E., 1964, A review of pozzolanic materials and their use in concretes in Symposium on Use of pozzolanic materials in mortars and concretes: American Society for Testing Materials, p. 3-15.

Duval Corporation, 1976, Mining Lease No. 14-20-0450-6750, Letters, .Location map, and drill logs of 65 drill holes: Office files of Gila River Indian Community.

Eaton, G. P., Peterson, D. L., and, Schumannn, H. L.,1972, Geophysical, geohydrological, and geochemical reconnaissance of the Luke salt body, Central Arizona: U.S. Geological Survey Professional Paper 753, 28 p.

Eyde, T. H., 1978, Bowie zeolite, an Arizona industrial mineral, fieldnotes, v. 8, no.4: "Arizona State Bureau of Geology and Mineral Technology, p. 1-5.

Eyde, T. H., and Irvin, G. W., 1979, Arizona zeolites: Arizona Department of Mineral Resources, Mineral Report No. 1, 40 p.

Hahman, W. R., Stone, C., and Witcher, J. C., 1978, Geothermal energy resources of Arizona: Arizona Bureau of Geology and Mineral Technology Geothermal Map 1, 1 p.

Hanna Mining Company, 1978: Annual Report for 1977, p. 14.

James Sullivan Company, 1974, Gila Prospect, Casa Grande, Sacaton Area, Pinal County, Arizona, Extracts from reports by Ralph M. Parsons Company, J. W. Simpson, and R.E. Mieritz: Office files of Gila River Indian, Community, 12 p.

Johnson, M. C., 1972, Placer gold deposits of Arizona: U.S. Geological Survey Bulletin 1355, 103 p.

Keith, S. B., 1978, Origins of Arizona copper deposits: hypotheses: Field notes, v. 8, p. 9.

Landwehr, W. R., 1967, Belts of major mineralization in Western United States: Economic Geology, v. 62, p. 494-501.

Lausen, Carl, 1927, Quicksilver resources of Arizona: Arizona Bureau of Mines Bulletin 122, 112 p.

Lee, W. T., 1904, Underground waters of Gila Valley, Arizona: U.S. Geological Survey Water Supply Paper 104, 71 D.

Lee, W. T., 1905, Underground waters of Salt River Valley, Arizona: U.S. Geological Survey Water Supply Paper 136, 196 p.

Lippincott, J. B., 1900, Storage of water on Gila River, Arizona: U.S. Geological Survey Water Supply Paper 33, 98 p.

McDonald, H. R., Wolcott, H. N., and Hem, J. D., 1947, Geology and ground water resources of the Salt River valley area, Maricopa and Pinal Counties, Arizona: U.S. Geological Survey Open-File Report, 45 p.

Mielenz, R. C., 1948, Materials for pozzolan; A report for the engineering geologist: U.S. Bureau of Reclamation, Petrographic Laboratory Report Pet-90, 25 p.

Mills, H. N., 1975, Glass raw materials in Industrial Minerals and Rocks, 4th edition: American Institute of Mining Metallurgical and Petroleum Engineers, p. 327-334.

Moore, R. T., and Varga, R. J., 1976, Maps showing nonmetallic mineral deposits in the Phoenix area, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-845-J.

Newell, F. H., 1891, Hydrography of the arid regions of the United States: U.S. Geological Survey, Twelfth Annual Report, p. 213-361.

Nulle, R. A., 1974, Letter from Chairman of the Board of Greshman Geophysical Corporation to Wilbert J. Carlyle, Chairman of the Ak-Chin Indian Community: Office files of the Ak-Chin Indian Community.

Parson, G., 1973, Exxon Company Final Report on Gila River Project #3363, Permit No. PP-457-73-1: Office files of Gila River Indian Community, 3 p. plus geology, geophysical and geochemical maps, charts, and drill logs.

Pay Dirt, 1974, Detective work led way to Sacaton discovery: Issue No. 417 (March 25), Bisbee, Arizona, p. 6 and 8.

Peterson, D. L., Mabey, D. R., and Conradi, Arthur, Jr., 1963, Gravity and aeromagnetic surveys in the area of the Central Arizona Project: U.S. Geological Survey Technical Letter, 32 p.

Ross, C. P., 1923, The Lower Gila Region Arizona: U.S. Geological Survey Water Supply Paper 498, 237 p.

Sellers, W. D., 1960, Arizona climate: Institute of Atmospheric Physics, University of Arizona, and U.S. Weather Bureau, 60 p. plus tables.

Sellers, W. D., and Hill, R. H., 1974, Arizona climate 1921-1972: University of Arizona Press, Tucson, Arizona, 616 p.

U.S. Bureau of Indian Affairs Staff, 1978, Information Profiles of Indian Reservations in Arizona, Nevada and Utah: Phoenix Area Office, 196 p.

U.S. Bureau of Mines Staff, 1969, Pozzolanic raw materials resources in the central and western United States: U.S. Bureau of Mines Information Circular 8421, 117 p.

U.S. Department of Commerce Staff, 1974, Federal and State Indian Reservations and Indian Trust Areas: 604 p.

U.S. Geological Survey, Arizona Bureau of Mines, and U.S. Bureau of Reclamation, 1969, Mineral and Water Resources of Arizona: Report for the U.S. Senate Committee of Interior and Insular Affairs, 638 p.

Wertz, J. B., 1970, The Texas Lineament and its economic significance in southeast Arizona: Economic Geology, v. 65, no.2, p. 166-181.

White, N. D., 1963, Ground water conditions in the Rainbow Valley and Waterman Wash areas, Maricopa and Pinal Counties, Arizona: U.S. Geological Survey Water Supply Paper 1669-F, 50 p.

Wilson, E. D., 1952, Arizona gold placers and placering: Arizona Bureau of Mines Bulletin 160, 124 p.

_____,1962, A resume of the geology of Arizona: Arizona Bureau of Mines Bulletin 171.

_____,1969, Mineral deposits of the Gila River Indian Reservation, Arizona: Arizona Bureau of Mines Bulletin 179, 34 p.

Wilson, E. D., Cunningham, J. B., and Butler, G. M., 1934, Arizona lode gold mines and gold mining: Arizona Bureau of Mines Bulletin 137, 26 p.

Wilson, E. D., Moore, R. T., and Pierce, H. W., 1957, Geologic Map of Maricopa County, Arizona: Arizona Bureau of Mines, 1 p.

Wilson, E. D., and Roseveare, G. H., 1949, Arizona non-metallics, summary of past production and present operations: Arizona Bureau of Mines Bulletin 155, 60 p.

Click back button (<<) on toolbar to return to text

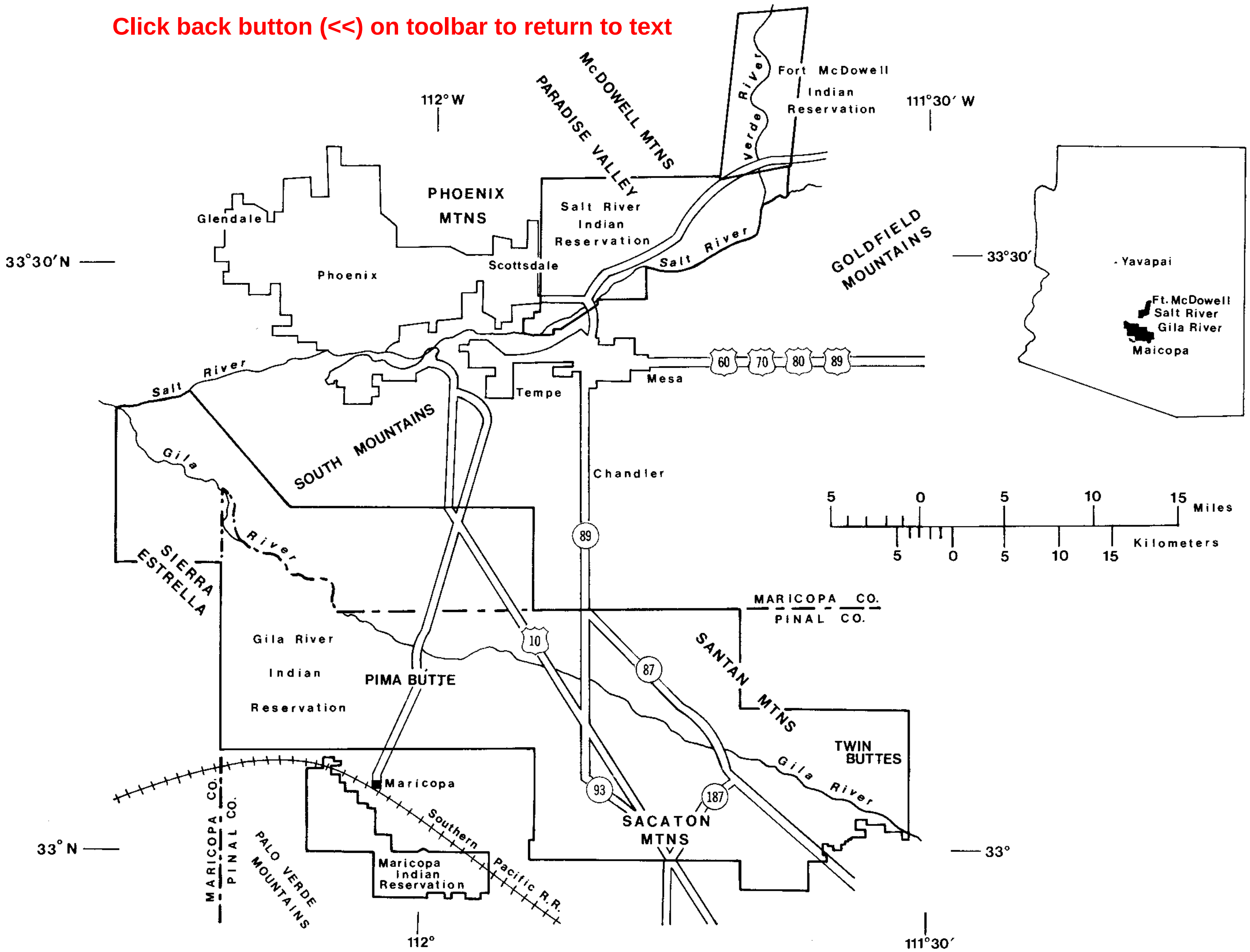

Figure 1. Index map showing locations of the Gila River, Maricopa (Ak-Chin), Salt River and Fort McDowell Indian Reservations (from Moore and Varga, 1976).

Click back button (<<) on toolbar to return to text

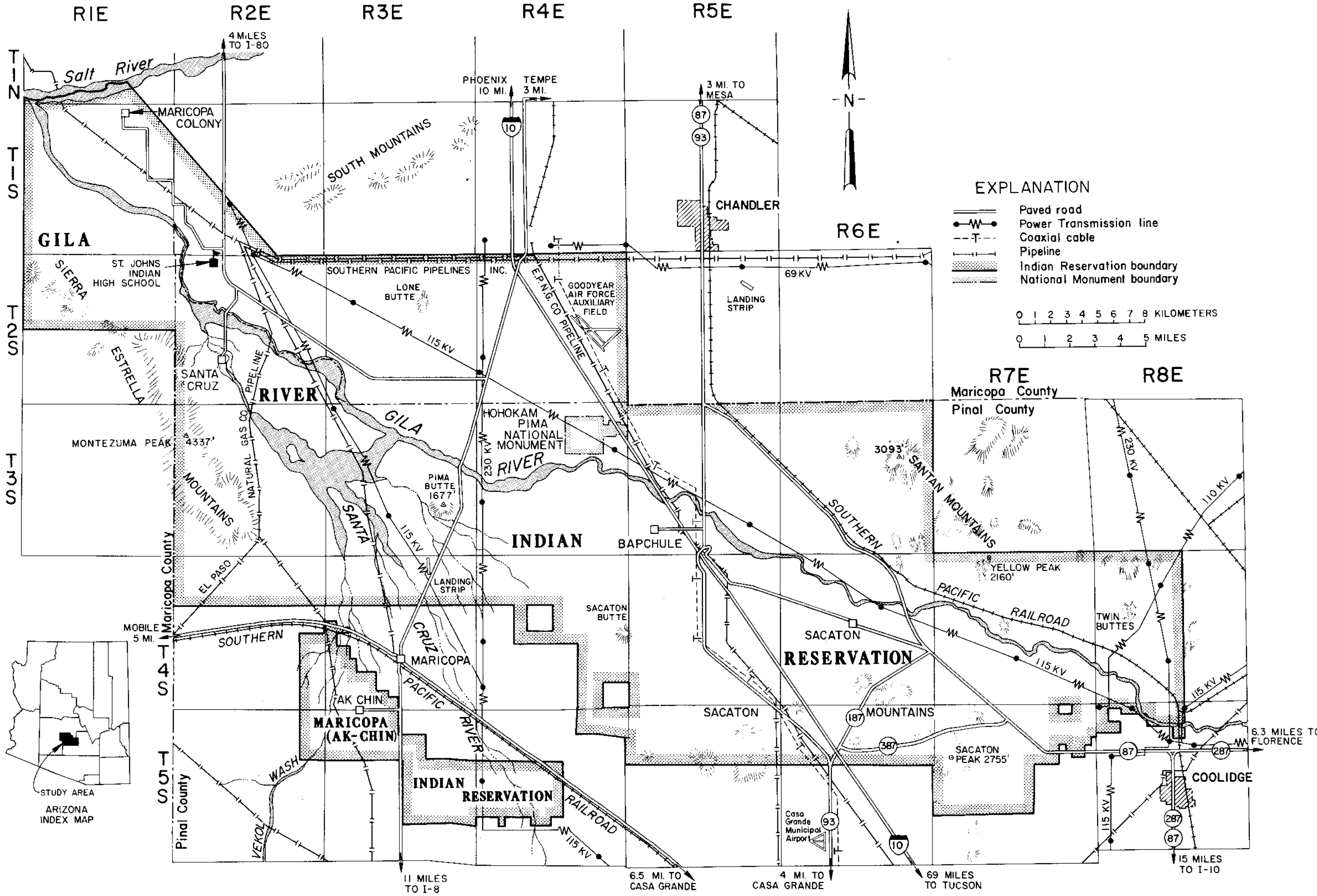

Figure 2. Map of the Gila River and Maricopa (Ak-Chin) Indian Reservations, Maricopa and Pinal Counties, Arizona.

Click back button (<<) on toolbar to return to text

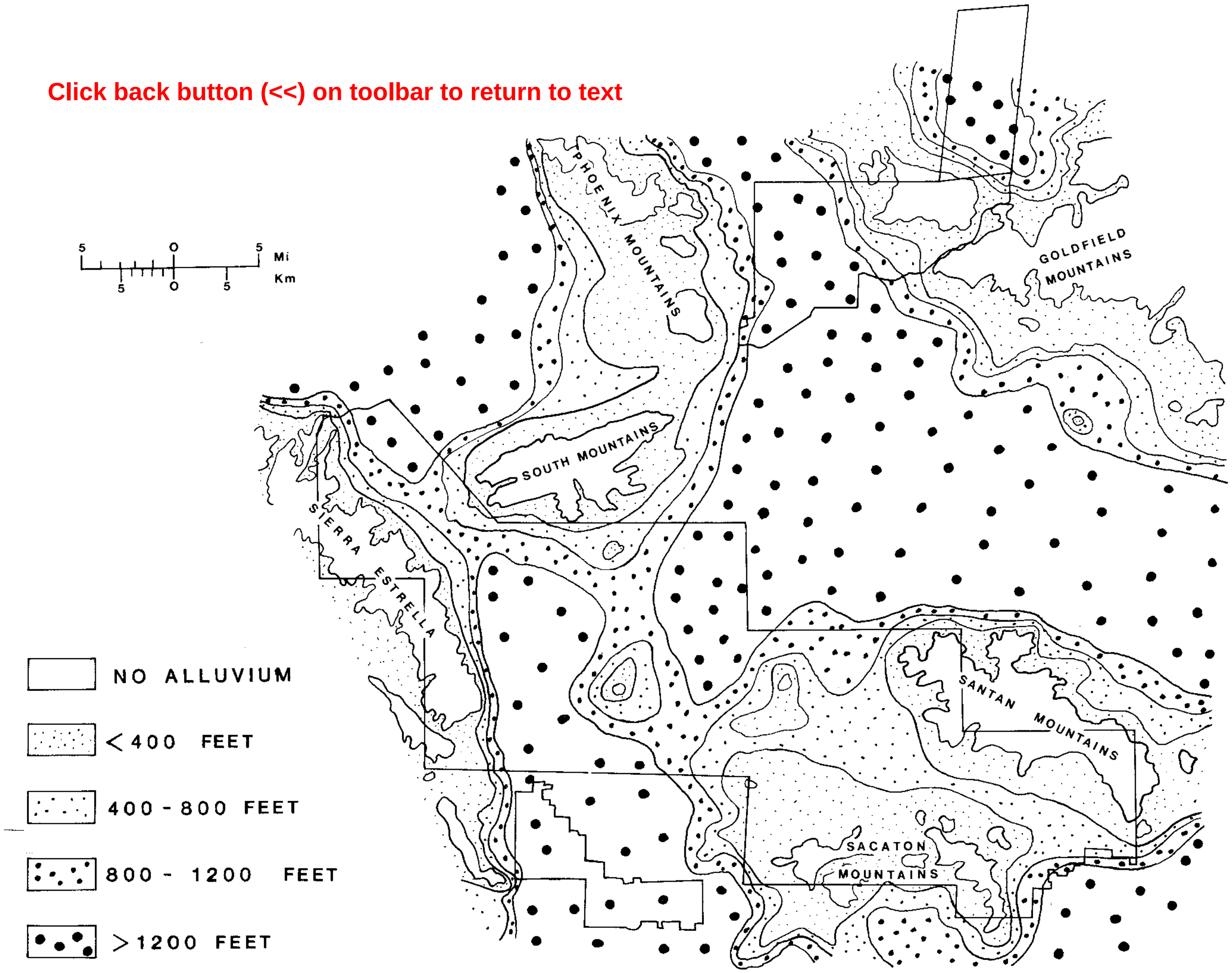

Figure 3. Map showing thickness of alluvial deposits in the Phoenix area (from Cooley, 1973).

Click back button (<<) on toolbar to return to text

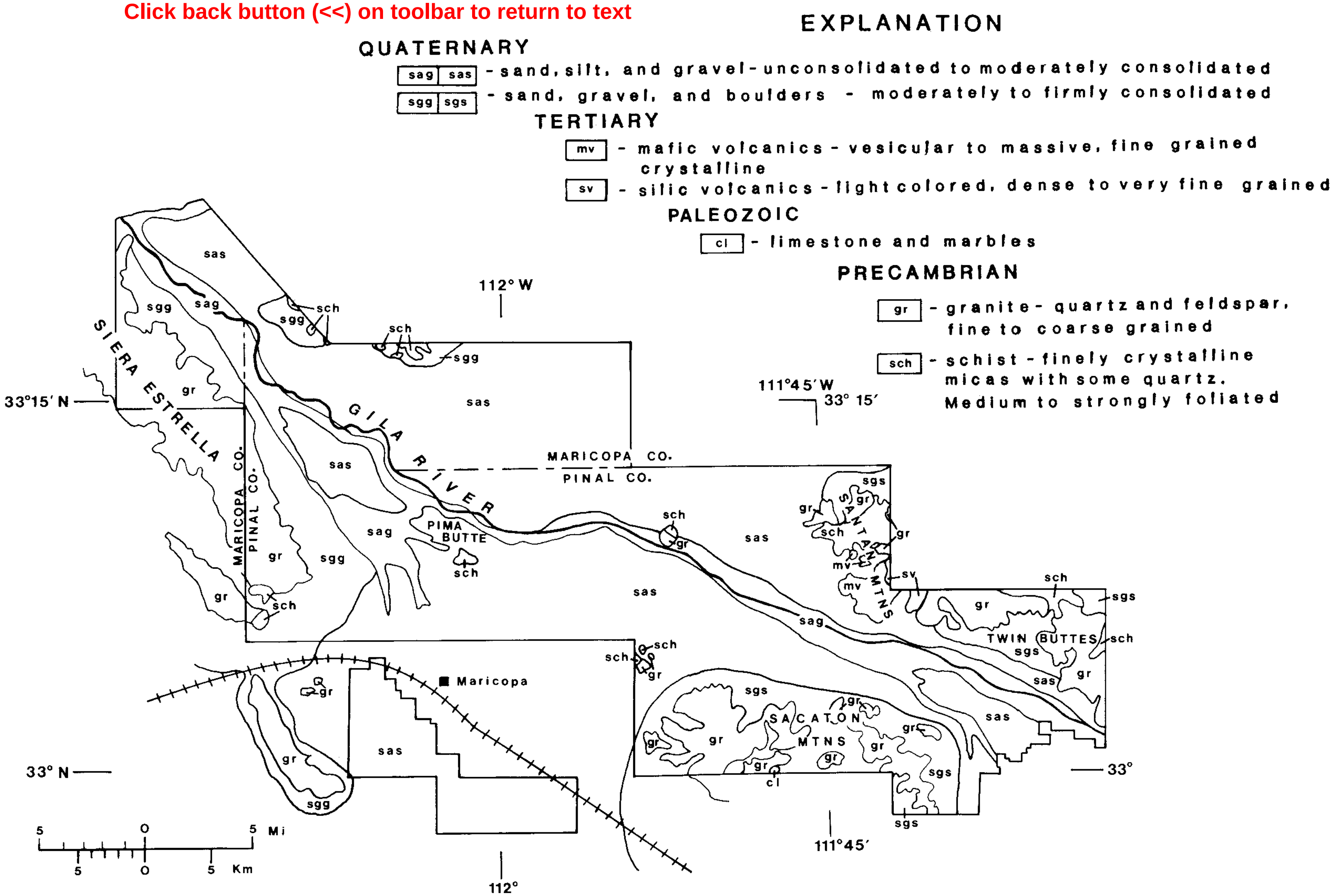

Figure 4. Geologic map of the Gila River and Maricopa Indian Reservations, modified from Moore and Varga (1976).

Click back button (<<) on toolbar to return to text

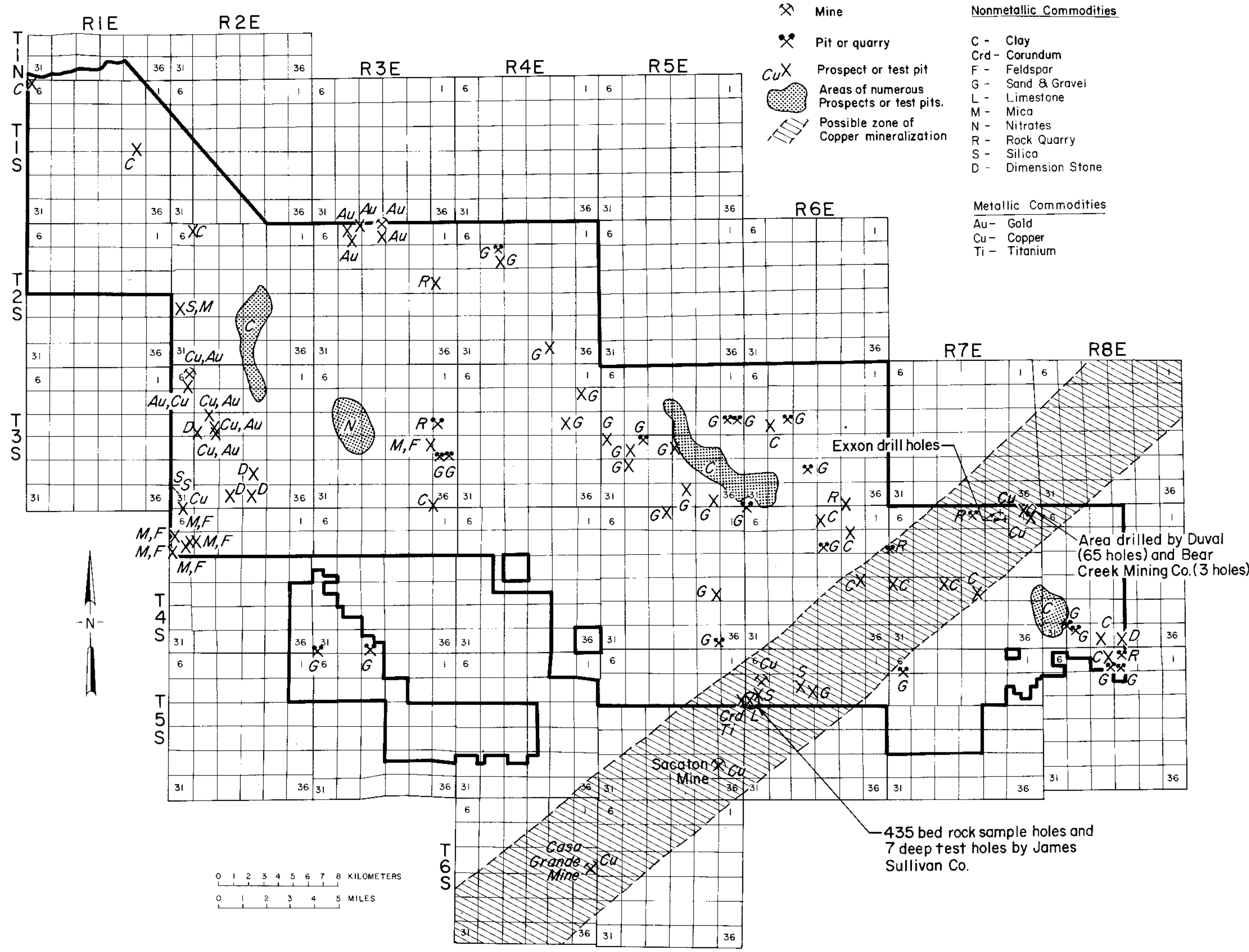

Figure 5. Map showing mineral deposits on and near the Gila River and Maricopa (Ak-Chin) Indian Reservations, Arizona (Adapted from E.D. Wilson and USGS Maricopa Quadrangle map).

Click back button (<<) on toolbar to return to text

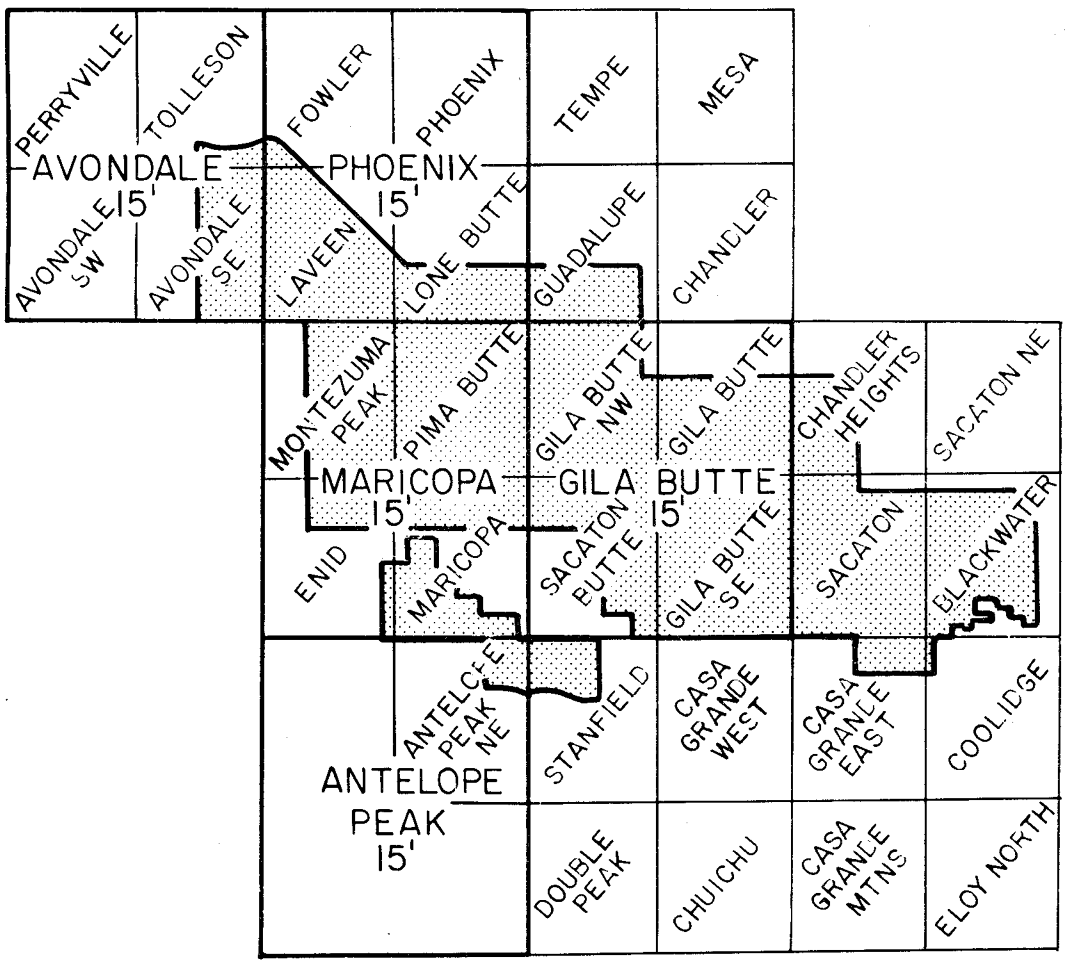

Figure 6. Map showing U.S. Geological Survey topographic map coverage of the Gila River and Maricopa (Ak-Chin) Indian Reservations, Arizona.